

DEPARTMENT OF THE ARMY CORPS OF ENGINEERS KANSAS CITY DISTRICT



Final RECORD OF DECISION FOR THE FINAL REMEDIAL ACTION FOR OPERABLE UNIT 2 GROUNDWATER AT THE FORMER WELDON SPRING ORDNANCE WORKS SITE

WELDON SPRING, MISSOURI



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LIST OF ACRONYMS AND ABBREVIATIONS

ARARs Applicable or Relevant and Appropriate Requirements

BLRA Baseline Risk Assessment

CERCLA Comprehensive Environmental Response, Compensation, and Liability Act

COC Contaminant of Concern CPA Chemical Plant Area

CSR Code of State Regulations

DNB 1,3-dinitrobenzene
DNT 2,4-dinitrotoluene

DOD U.S. Department of Defense DOE U.S. Department of Energy

EPA U.S. Environmental Protection Agency

FS Feasibility Study

GMAR Groundwater Monitoring Assessment Report

HQ hazard quotient

IAG Inter-Agency AgreementICs institutional controlsK hydraulic conductivity

MDNR Missouri Department of Natural Resources

MDOC Missouri Department of Conservation

MNA Monitored Natural Attenuation
MWQS Missouri Water Quality Standard

 $\begin{array}{ll} \mu g/L & \text{micrograms per liter} \\ mg/L & \text{milligrams per liter} \end{array}$

NB nitrobenzene

NCP National (Oil and Hazardous Substances Pollution) Contingency Plan

NPL National Priorities List

NT nitrotoluene

OU1 Operable Unit 1, Soils and Process Pipelines

OU2 Operable Unit 2, Groundwater
PRG preliminary remediation goal
RAB Restoration Advisory Board
RAOs Remedial Action Objectives

RI Remedial Investigation ROD Record of Decision



SARA Superfund Amendments and Reauthorization Act (to CERCLA)

TNT 2,4,6-trinitrotoluene

USACE U.S. Army Corps of Engineers

WAA War Assets Administration

WSOW Weldon Spring Ordnance Works

WSS Weldon Spring Site

WSTA Weldon Spring Training Area



1.0 DECLARATION

SITE NAME AND LOCATION

Former Weldon Spring Ordnance Works/

Weldon Spring Former Army Ordnance Works (Name in CERCLIS)

Weldon Spring, Missouri Operable Unit 2: Groundwater

CERCLIS Identification Number: MO 5210021288

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected final remedial action for Operable Unit 2 (OU2) Groundwater at the Former Weldon Spring Ordnance Works (WSOW) site in Weldon Spring, Missouri. The remedial action was chosen in accordance with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (SARA) and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the administrative record for this site. The Army will fulfill its responsibility and obligation under CERCLA and the NCP as it implements, maintains, and when necessary, reviews the selected remedy.

The remedial action was jointly selected by the U.S. Army and the U.S. Environmental Protection Agency (EPA) in consultation with the Missouri Department of Natural Resources (MDNR).

ASSESSMENT OF THE SITE

Actual or threatened releases of contaminants from this site, if not addressed by implementing the response action selected in the Record of Decision (ROD), may present a current or potential threat to public health, welfare, or the environment.

DESCRIPTION OF THE FINAL SELECTED REMEDIAL ACTION

The remedial action for OU2 Groundwater addresses the groundwater contamination at the site by Monitored Natural Attenuation (MNA). MNA involves the collection of monitoring data to verify the effectiveness of naturally occurring processes to reduce contaminant concentrations over time. For the WSOW, the primary natural processes occurring in groundwater are dilution, sorption, and dispersion with secondary benefits from biodegradation and photolytic breakdown. This ROD establishes remedial goals for MNA. It also establishes expectations for groundwater use restrictions to protect human health and the environment until remediation goals are achieved.

This ROD addresses the second of two operable units for the WSOW. A ROD for the first operable unit, OU1, previously addressed the remediation of contaminated soil and underground pipeline primarily by incineration with both on-site and off-site land disposal of materials. OU1 addressed the principal threat at the WSOW. The OU1 ROD was signed in 1996 with an Explanation of Significant Differences signed in 2004 which documented events that occurred during remedial action deemed significantly different, but not fundamentally different, from the ROD. OU1 remediation activities were completed in July 2004. The OU1 remediation effort



significantly reduced and/or eliminated known sources of explosives contamination to groundwater.

Major components of the selected OU2 Groundwater remedy include:

- Collection of monitoring data to verify the effectiveness of naturally occurring processes to reduce contaminant concentrations.
- Use of select wells from the existing groundwater monitoring network to collect groundwater data. Use of select springs at the site for additional monitoring data. The initial monitoring network will be presented during remedial design. This network will be modified over time, if necessary, to aid in evaluation of progress toward the RAO. This modification may include installation of new monitoring wells.
- Institutional controls in areas which exceed remediation goals designed to limit ingestion or dermal exposure to groundwater. The institutional controls would also restrict activities that may negatively impact the remediation of contamination or result in creation of a potential for downward migration of contamination.

The remedy selected in this ROD is the final remedy for the Former WSOW and the final planned response action for the site.

STATUTORY DETERMINATIONS

The selected remedial action is protective of human health and the environment, complies with Federal and State laws and regulations that are applicable or relevant and appropriate to the remedial action, and is cost effective. The remedial action utilizes permanent solutions and alternative treatment technologies to the extent practicable. At the end of five years, a five-year review will be required for this remedy in accordance with CERCLA Section 121(c).



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EPA Region VII

Superfund Division Director

DATE



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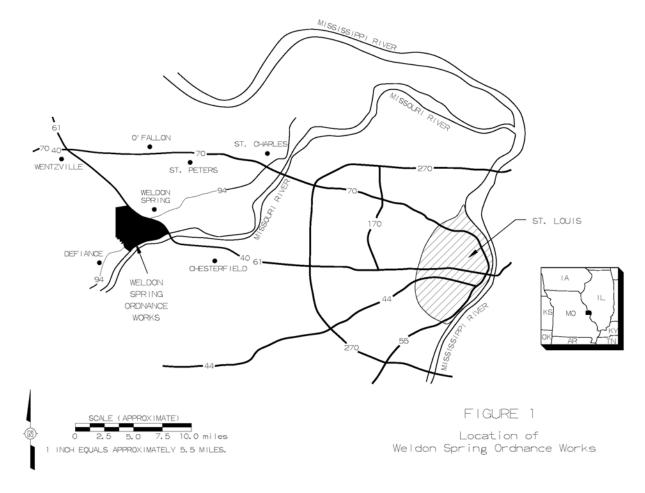
*Per the September 30, 2004 concurrence letter.



2.0 DECISION SUMMARY

2.1. SITE NAME, LOCATION, AND DESCRIPTION

The Weldon Spring Ordnance Works (WSOW) is located in St. Charles County, approximately 30 miles west of St. Louis, Missouri and about 14 miles southwest of the City of St. Charles. (Figure 1). It is bisected by State Highway 94, bounded on the north by U.S. Highway 40-61 and bounded on the south by the Missouri River. The original property of the WSOW consisted of 17,232 acres. Following 1946, the property was subsequently divided with most of the land (all but 2,000 acres) being transferred to the State of Missouri and the University of Missouri. The former Ordnance Works property at the present time includes the Weldon Spring Training Area (WSTA), Busch Conservation Area, Weldon Spring Conservation Area, Francis Howell High School, Weldon Spring Heights and the Missouri Research Park (Figure 2).



A portion of the original WSOW, 205 acres, was transferred in 1955 to the U.S. Atomic Energy Commission with an additional 15 acres from the Weldon Spring Training Area conveyed in 1964 for the construction and operation of Weldon Spring Uranium Feed Materials Plant. The plant was active from 1957 through 1966 and processed uranium and thorium ore concentrates. This area is now referred to as the Chemical Plant Area (CPA) and is part of the Weldon Spring Site (WSS). The WSS also includes a quarry area in the south of the WSOW (Figure 2). This site was placed on the National Priorities List (NPL) in 1987, and the U.S. Department of Energy



(DOE) is the lead agency for actions at the WSS. The remainder of the WSOW is the approximate extent of the designated WSOW NPL site (Figure 2).

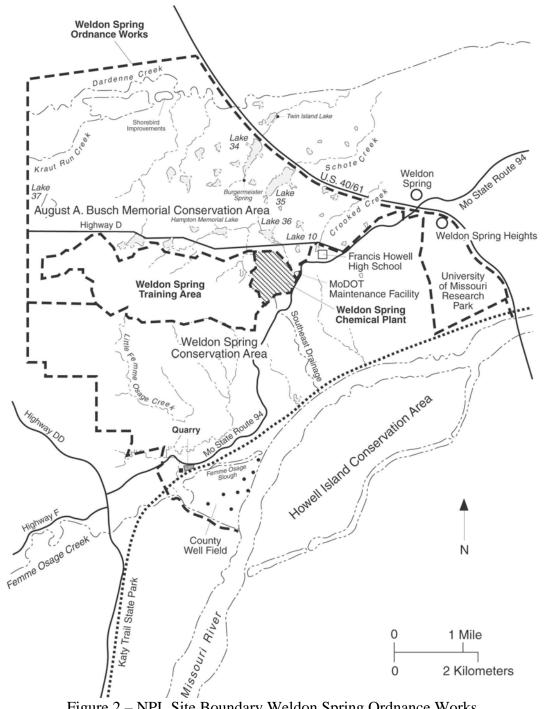


Figure 2 – NPL Site Boundary Weldon Spring Ordnance Works



This document addresses the final remedy selection for OU2 Groundwater at the former Weldon Spring Ordnance Works. The OU2 Groundwater addresses groundwater contamination from activities occurring during production of trinitrotoluene (TNT) and dinitrotoluene (DNT) explosives during World War II.

2.2. SITE HISTORY

The WSOW operated from 1941 through 1945 as an explosives production facility to support war efforts during World War II. The WSOW produced TNT and DNT explosives. The WSOW was operated under contract by the Atlas Powder Company. Approximately 5,200 employees operated the facility in 1943 when the plant reached a peaked annual production of 164,000 tons of explosives. In January 1944, the TNT and DNT plants and support facilities were taken out of operation and placed on standby status. During this period, most of the production equipment and buildings were dismantled, cleaned, repaired, and "mothballed". In July 1944, reactivation was ordered and the entire WSOW was reassembled. Production continued until August 1945 when the contractor was notified to cease operations.

The Army's Ordnance Department reassumed operations of WSOW from Atlas Powder Company in November 1945. The property was declared surplus in April 1946 and transferred to the War Assets Administration. WAA began transfer of WSOW property to various entities in 1949.

The WSOW was listed on the NPL on February 21, 1990 and is now being addressed under guidelines established in a three party Inter-Agency Agreement (IAG) effective August 8, 1991 between EPA Region VII, MDNR, and the U.S. Army. The U.S. Army is the lead agency for this site.

2.2.1. Previous Investigations

Operable Unit 1: Soils and Pipeline

OU1 addressed soils and pipelines associated with the former ordnance works. The remedial action included excavation and treatment of explosives-contaminated soils and pipeline that exceeded remediation goals. The remedial action also included disposal of contaminated materials in the DOE disposal cell and at approved off-site facilities. Approximately 120,000 tons of contaminated material was addressed under OU1. The primary goal of this remedial action was to eliminate adverse health effects from long-term exposure to soils and address safety concerns related to the pipelines. In addition, this selected and implemented remedial action significantly reduced and/or eliminated known sources of groundwater contamination at the former WSOW. This action is expected to eliminate further migration of nitroaromatic compounds in soils and reduce the potential for impacting groundwater. The OU1 ROD was signed in 1996 with an Explanation of Significant Differences signed in 2004. OU1 remediation activities were completed in July 2004.

Operable Unit 2: Groundwater

In 1995, the U.S. Army Corps of Engineers (USACE) began the OU2 Remedial Investigation (RI). The primary objective of the OU2 RI was to evaluate the nature and extent of contamination by the chemicals of concern in the groundwater at the site attributable to former Department of Defense activities.



During the OU2 RI, it was determined that groundwater contamination at the site did not pose a threat to human health from recreational exposures nor did it pose potentially significant ecological risk. However, some areas on the WSOW were identified as having contaminant concentrations that exceeded federal and/or state levels for groundwater and/or surface water with regards to ingestion. Preliminary Remediation Goals (PRG) for OU2 were then proposed in a 1998 Feasibility Study (FS) that presented remedial alternatives for both the WSOW and the CPA sites, (a joint effort between the Army and DOE). The PRGs for groundwater that are presented in the 1998 FS are based on federal and state levels and a residential exposure scenario.

As part of the OU2 RI activities, an extensive groundwater monitoring program was instituted at the WSOW. A series of 83 monitoring wells and several springs have been periodically monitored (January 1990 to August 2003). The purpose of the monitoring program was to evaluate contaminant trends in the groundwater and identify whether natural processes could sufficiently reduce the concentration levels of groundwater contaminants. The Groundwater Monitoring Assessment Report (GMAR) concluded that natural attenuation of the contaminants was feasible at the WSOW with dilution and dispersion as the dominant natural processes.

2.3. COMMUNITY PARTICIPATION

The Proposed Plan was made available to the public in June 2004. A copy of the Administrative Record File, which contains the Proposed Plan and its supporting documentation (remedial investigation/ feasibility report and other related reports), is located at the St Charles City/County Library District, Middendorf-Kredell Branch, 2750 Hwy K, O'Fallon, Missouri.

The notice of availability of the Proposed Plan and date of the public meeting was published May 28, 2004 in the St. Peters Suburban Journal. The public comment period was held from to June 11, 2004 to July 12, 2004. A public meeting was held on June 24, 2004 at the St. Charles Community College. At the public meeting, the Army presented an overview of the preferred alternative and explained the decision making process. Representatives from EPA and MDNR were present at the meeting and provided statements. A transcript of the meeting is available in the Administrative Record. Responses to substantive comments received at the meeting and during the comment period are provided in the Responsiveness Summary.

In addition, the Army established a Restoration Advisory Board (RAB) comprised of members of the public. The RAB was created in 1997 by converting the existing Technical Review Committee to a RAB by adding community members. Meetings are held on a regular basis with these community members to discuss various issues concerning the site. These discussions include progress updates at the site and the proposed remedial action.

The Army has also conducted community surveys (as early as 1991), distributed newsletters (as early as 1992), conducted public meetings (as early as 1987), developed a information website, and distributed mailings to interested persons.



2.4. SCOPE AND ROLE OF OPERABLE UNIT 2: GROUNDWATER

The Army has addressed the Weldon Spring Ordnance Works Site cleanup through a series of response actions. The Site was divided into two operable units:

• Operable Unit 1: Soils and Pipeline

• Operable Unit 2: Groundwater

The scope of the response action for OU1 was to excavate and treat explosives contaminated soils and the pipeline which exceeded the remediation goals, to utilize off-site disposal for small quantities of hazardous waste, and to land dispose at the Department of Energy disposal cell lead contaminated material following stabilization.

The contaminated soils and pipeline were the principal threats to human health and the environment at the site because of the risks of possible ingestion and dermal contact. The purpose of the response action was to prevent current exposure to the soils and to reduce contaminant migration to groundwater. The response action was designed to allow unimpeded use of WSTA for military activities and the remaining parts of the WSOW for occupational, recreational, and ecological activities. As part of the overall remediation strategy, the selected action for OU1 significantly reduced and/or eliminated the major known sources of groundwater contamination at the WSOW. The OU1 ROD was finalized in September 1996. An Explanation of Significant Differences was signed July 2004.

Operable Unit 2 Groundwater, which is the subject of this ROD, addresses residual contamination of the groundwater aquifer. During the OU2 RI, it was determined that the groundwater contamination at the site did not pose a threat to human health from recreational exposure nor did it pose a potentially significant ecological risk. However, some areas on the WSOW were identified as having contaminant concentrations that exceeded federal and state levels for groundwater and surface water. This ROD presents the selected remedy for groundwater and is the final remedy for the Weldon Spring Ordnance Works Site.

2.5. SITE CHARACTERISTICS

2.5.1. Contamination Under Current Conditions

The groundwater contamination encountered at the former WSOW is a result of nitroaromatic compounds leaching into the groundwater system from numerous historical surface and shallow subsurface releases associated with the former ordnance activities. The known nitroaromatic source areas within the soil, former process pipelines and other physical structures, were addressed through various remedial actions performed under OU1. All areas identified as having concentrations exceeding remediation goals (57 mg/kg for TNT and 2.5 mg/kg for DNT) were remediated. Remediation goals were achieved at all identified areas with the exception of T13 at depth.

Approximately 1500 cubic yards of contaminated soil was remediated at T13 to depths as great as 22 feet below ground surface. A significant potential source of groundwater contamination was removed as a result. However, it is estimated that up to 428 cubic yards of contaminated soil may remain at T13 having concentration of less than 46 mg/kg DNT. T13 is upgradient of MW16 and is within the SP-5601/5603/5605 spring basin recharge area.



Residual contamination still exists within the weathered surface, fractures, and solution features of the underlying limestone bedrock. Some areas on the WSTA have been identified with dilute fractions of nitroaromatic compounds that still exceed remediation goals for OU2.

Various nitroaromatic compounds are the contaminants of concern at the WSOW. The nitroaromatic compounds include: 2,4,6-Trinitrotoluene (TNT), 2,4-Dinitrotoluene (2,4-DNT), 2,6-Dinitrotoluene (2,6-DNT), o-Nitrotoluene (o-NT), m-Nitrotoluene (m-NT), p-Nitrotoluene (p-NT) and Photolytic Degradation Products 1,3-Dinitrobenzene (DNB) and Nitrobenzene (NB).

Nitroaromatic Compounds

The recent monitoring program has consisted of collecting samples from 83 wells and 13 springs throughout the WSOW. The network of wells and springs that were monitored at the WSOW are shown in Figure 3. The monitoring program demonstrated the areas at which contamination exceeded the Preliminary Remediation Goals (PRGs). These PRGs are carried forward as Remediation Goals (RGs).

The RGs are based on state of Missouri water quality standards for 2,4-DNT and 1,3-DNB, and NB are $0.11~\mu g/L$, $1.0~\mu g/L$, and $17~\mu g/L$, respectively. There are no federal standards for the nitroaromatic compounds of concern at WSOW. RGs for 2,6-DNT, o-NT, p-NT, m-NT, and TNT are risk-based (see section 2.7 and 2.8).

Figure 3 depicts the extent of groundwater contamination for contaminants of concern for the WSOW NPL site. These impacted areas are identified by color-coding of Spring Basin Recharge areas identified using dye-trace study data collected by the MDNR Division of Geology and Land Survey (Figure 3). Contamination is limited to the shallow bedrock aquifer (Burlington-Keokuk) or the springs at the WSOW. Contamination is not impacting the deeper aquifer or the sand and gravel alluvial aquifer of the Missouri River.

Of the 13 monitoring points at the WSOW (See Figure 3) with concentrations of nitroaromatics exceeding the RGs, eight are located on the WSTA. Of the five other monitoring points with exceedances of RGs, two points are located north of the WSTA within the same spring recharge basin and are of the same order of magnitude as the RGs. These points are all within the boundaries of the WSOW.

The remaining three monitoring points are located to the south and southeast of the WSTA (also within the boundaries of the WSOW). The monitoring points are springs located at a distance of 0.5 to 1.5 miles from the nearest road access across rugged terrain. Concentrations of nitroaromatics in these springs range from 1 to 2 orders of magnitude over the RGs but are still at concentrations that meet an acceptable recreational exposure scenario (see section 2.7, Summary of Site Risks).

Table 2.5-1 provides details on the specific monitoring points with mean concentrations exceeding RGs. For each monitoring point with an exceedance of RGs, there is at least one downgradient monitoring point within the WSOW that is at or below the RGs. In most cases, the



most downgradient monitoring point within the boundaries of the WSOW is non-detect for all nitroaromatics.

2.5.2. Site Hydrogeology

The WSOW lays predominately in the extreme southeastern portion of the Dissected Till Plain physiographic province. Rocks from the Ozark Plateau physiographic province extend across the Missouri River and into the glaciated river hills in the southernmost portions of the WSOW. The primary structural feature on the WSOW is the approximately 60 –70 feet per mile dip to the northeast of the site. Unconsolidated overburden at the site consists mainly of silty, sandy and gravely clays and silts containing an increasing amount of residual chert and carbonate fragments with depth. Underlying the unconsolidated overburden are the Mississippian-age carbonate units referred to as the Burlington-Keokuk Formation, Fern Glen Formation, and the Chouteau Group. Beneath these lie the Devonian-age and Ordovician age units. Localized unit fractures and joints occur both horizontally and vertically within the Burlington Keokuk formation.

A surface water drainage divide exists between the Missouri and Mississippi Rivers which bisects the Site in an approximately east to west direction. Surface water running from the northern half of the Site flows along gently rolling plains to the Dardenne Creek, a tributary of the Mississippi River. Surface water in the southern portion of the Site flows in steep, well-channeled ravines toward the Missouri River. Surface water drainage both to the northeast and southeast moves between losing and gaining stream segments and a series of springs before reaching the river.

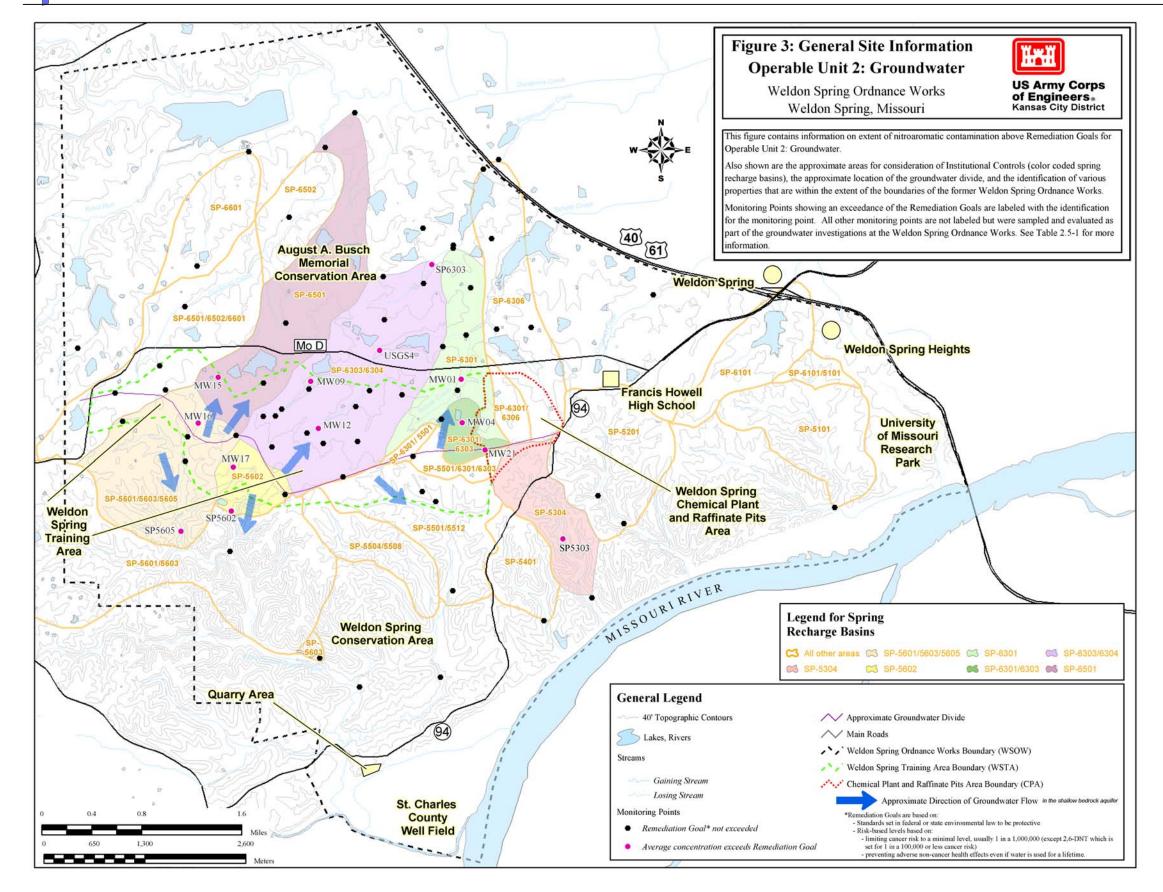
Three aquifers have been identified in the site area. They are the sand and gravel alluvium of the Missouri River, the shallow bedrock aquifer (Burlington-Keokuk) and the deeper bedrock aquifer (St. Peter Formation). The deeper bedrock aquifer is separated from the shallow zone by a confining unit known as an aquitard.

The occurrence of groundwater in the overburden varies across the site and depends on a variety of factors such as the permeability and thickness of the overburden materials and surface drainage. Rate of groundwater movement within the fractured/karst bedrock aquifer also may vary significantly across the site and can easily range three to five orders of magnitude. Such variation is indicative of the nature of fracture/solution flow and the variable site conditions in general at the former WSOW. However in general, hydraulic conductivity values (K) in the weathered bedrock range from 10^{-4} to 10^{-1} ft/day. The result is a range of groundwater flow velocities in the weathered bedrock of 0.0146 to 14.6 ft/yr.

Depending on the extent of the karstic nature of the weathered bedrock, velocities can be considerably higher. During a dye trace study performed by the Missouri Department of Natural Resources in 1991, dye movement across the 5600 series spring basin from an ephemeral creek near MW18 to SP5601 equated to a groundwater velocity of nearly 10,000 ft/day. This study took place immediately following a precipitation event.

As with surface water, a groundwater divide also exists running roughly east to west across the main portion of the site (Figure 3). Both surface and shallow groundwater flows towards the







Mississippi River north of the divide, in north to northeasterly trends, and towards the Missouri River south of the divide. Both groundwater and surface water flows north and south of the divide along a series of drainage and recharge basins defined by previous MDNR dye trace studies performed in 1991. Water flowing through these basins may cross between the surface and subsurface several times via streams, springs, sinks and other karst features before reaching surface water creeks and rivers.

As previously stated, the WSTA is located on an east-west surface water drainage divide between the Missouri and Mississippi Rivers watersheds. Surface drainage in this area has been divided into a series of drainage basins in accordance with previous studies and topography. Surface drainage to the south of the divide generally flows through the 5000-5600 series drainage and discharges to the Missouri River. Surface drainage to the north of the divide flows toward Dardenne Creek and its tributaries via the 6000-6600 series. Schote Creek, the largest of these tributaries, drains central and eastern portions of the WSTA. Dardenne Creek then flows east to the Mississippi River.

Surface drainage north of the WSTA can be lost to losing stream segments and can discharge to nearby springs. Surface drainage along the heavily dissected terrain to the south and southeast also moves between losing and gaining stream segments and a series of springs before reaching the Missouri River. Surface water on the WSTA is only used for ecological needs. Surface water on the adjacent Missouri Department of Conservation (MDOC) properties (and part of the former WSOW) is used for ecological and recreational activities.

2.6. CURRENT AND FUTURE LAND AND RESOURCE USE

2.6.1. Current Land Use

The two communities closest to the site are Weldon Spring and Weldon Spring Heights, about 3.2 km (2 mi) to the northeast of the WSTA. The combined population of these two communities is about 5,000. No private residences exist between Weldon Spring Heights and the WSTA. Urban areas occupy about 6% of county land, and nonurban areas occupy 90%; the remaining 4% is dedicated to transportation and water uses Francis Howell High School is about 1 km (0.6 mi) northeast of the WSTA along Missouri State Route 94 and is occupied regularly by about 1,700 faculty, staff members, and students. With the exception of Weldon Spring, all of these areas are within the original boundary of the WSOW.

The WSTA is an active Army Reserve Training Area. Portions of the WSTA are also used by law enforcement personnel. The Missouri Department of Transportation Weldon Spring maintenance facility, located adjacent to the east and north of the WSTA, employs about 10 workers. About 300 hectares (741 acres) of land east and southeast of the high school is owned by the University of Missouri. The northern third of this land is being developed into a high-technology research park. The conservation areas surrounding the WSTA are operated by the MDOC and employ about 50 people. Two residences are located on the MDOC property north of the WSTA.

The CPA is adjacent to the WSTA to the east and is within the boundary of the former WSOW. The CPA includes a 24-hectares (60-acre) disposal cell facility that includes the 300-foot (91-meter) buffer that is under the custody of the DOE. Three buildings remain at the CPA. These



buildings include a small water treatment enclosure, an administrative building that is used by DOE and is available for use by local organizations, and an interpretive center provided by DOE for use by the public for obtaining information about the CPA and WSOW.

The DOE manages the CPA, a quarry site in the southern WSOW (Figure 3), and several other areas in the WSOW under the Weldon Spring Site Remedial Action Project.

2.6.2. Current Groundwater Use

The EPA classifies the groundwater system at the WSOW as a Type IIb-v aquifer with regards to vulnerability for contamination and projected groundwater use. The Type "II" classification ranks it as a current and potential source of drinking water with other beneficial uses in a sedimentary rock. The "b" and "v" subclassifications represent low groundwater yields (i.e., well yields typically less than 50 gpm), and indicates that variable thicknesses of low permeable sediments overlie the aquifer, respectively.

As a whole, the shallow aquifer beneath the boundaries of the WSTA is currently not used for drinking water or irrigation purposes. No domestic wells are known to be active within the WSTA, the adjacent CPA, or the August A. Busch Conservation area.

A well located on the WSTA, referred to as the Army Well, is located south of MWS-25 and north of MWS-26. This well is located in an area that is not currently impacted by nitroaromatics and yielded non-detect analysis results for nitroaromatics during the two groundwater monitoring rounds in which it was sampled (Round 1, 1989; and Round 2, 1990). Further, this well is inactive.

No active private wells are located within 1.6 kilometers (1 mile) of the WSTA. The closest active domestic water wells from the site are located 3.4 kilometers (2.1 miles) to the northnortheast. Although these wells produce water from the shallow aquifer, the potential for impact from contaminated groundwater is low due to their distance from the contamination and depth of the well screen.

An irrigation well is located at the Missouri Research Park within 3.2 kilometers (2 miles), of the impacted areas of the WSOW but is within the boundary of the original WSOW. This well is located cross gradient of the WSOW groundwater contamination which reduces the potential for any future impact.

The current source of water for the majority of residents in the area is municipal water provided by several companies. County zoning for future housing developments in the area of the WSTA indicate that when available, municipal water will continue to be the source of drinking water. There are several drinking water supply wells located within the boundaries of the WSOW. These wells are operated by St. Charles County and are located south of the quarry area in the alluvial aquifer (Shown in Figure 2 as the County Well Field).

The Weldon Spring Heights is located within the original boundaries of the WSOW. This community obtains drinking water from a well installed in the St. Peters Sandstone. This well is cross-gradient to the contamination within the shallow aquifer at the WSOW and is therefore not



likely to become contaminated in the future as a result of nitroaromatic contamination in the shallow bedrock aquifer.

Future land use for the WSTA include ownership and maintenance by the Department of Army as a field training area. Development of some of the training facilities may require a potable water supply. There are no current plans to alter the use of the property currently held by the MDOC.

Previous groundwater monitoring indicates that groundwater contamination is not migrating offsite, and any further increase in the extent of groundwater contamination is not expected.

2.7. SUMMARY OF SITE RISKS

The Baseline Risk Assessment (BLRA) prepared in 1997 for the WSOW provided estimates of the potential human health and ecological risks that would be posed by the site if no remedial action was taken. The human health risk assessment indicated that the site contamination levels are acceptable for a recreational visitor, but not for a resident. Further, groundwater concentrations for some of the nitroaromatic compounds exceeded federal or state standards. The ecological risk assessment indicated that contaminant concentrations in spring water and sediment pose little or no risk to ecological resources in the area and that remediation is not needed from an ecological perspective.

Tables 2.7-1 and 2.7-2 present summaries of the nitroaromatic non-cancer and cancer risk results presented in the BLRA, respectively.

The non-cancer risk estimate for the recreational visitor is derived from ingesting and wading in water at the spring with the highest non-cancer risk. As shown in Table 2.7-1, the Hazard Index for the recreational visitor due to nitroaromatic compounds present at this spring is 0.04. This Hazard Index is well below 1, indicating that adverse non-cancer health effects are not expected to occur to the recreational visitor. Table 2.7-1 also shows that groundwater consumption by a future resident at the well with the highest non-cancer risk would be associated with a Hazard Index of 2, indicating that adverse health effects might occur. The major contributor to nitroaromatic non-cancer health risks in the BLRA is TNT, which causes liver injury.

With respect to cancer, the recreational visitor may be exposed, (at the highest risk spring) to a cancer risk of up to $3x10^{-7}$. The National Contingency Plan states that acceptable exposure levels should generally have an upper bound of 10^{-6} to 10^{-4} cancer risk. The risk estimated for the recreational visitor thus falls well within the acceptable risk range. On the other hand, Table 2.7-2 shows that if a well were to be placed for the use of a future resident, cancer risks could be $2x10^{-4}$.

The overall conclusions of the ecological risk assessment were that there are no significant impacts as a result of contaminants in Burgermeister Spring (SP6301). The risk assessment noted that no clear toxicity gradient extending from the spring downstream was evident, suggesting that the Burgermeister Spring was not the source of toxicity. Further, a biological survey of the area indicated the presence of apparently unaffected biota (invertebrates, fishes, and amphibians) at sample locations associated with lab results indicating toxicity. The risk



assessment speculated that local populations had adapted to become tolerant of contaminants. Limitations in fish diversity and slight impairment of the invertebrate community were considered a result of natural temporal variations in the availability of aquatic habitats.

The spring was determined to contain generally good aquatic habitat, and the species present are typical of those found in similar habitats throughout the Midwest. Under low-flow conditions, as commonly occur in the summer, the stream drainage below the spring becomes intermittent, and portions of the habitat become dry. Surveys of amphibians found a community typical of similar habitats in the Midwest. Fish tissue analyses revealed relatively low levels of contaminant concentrations, all below levels of concern. No critical habitats or endangered species are impacted by the groundwater contamination.

The Risk Assessment results presented in this section serve as the basis for action, and show that the response action selected in this ROD is necessary to protect public health or welfare or the environment from actual or threatened releases of contaminants from this site that may present an imminent and substantial endangerment to public health or welfare.

2.8. REMEDIAL ACTION OBJECTIVES

The remedial action objective (RAO) is to minimize the potential for exposure either by ingestion, dermal contact, or inhalation of contaminated groundwater until concentrations are reduced to standards listed in Table 2.8-1.

2.9. DESCRIPTION OF REMEDIAL ALTERNATIVES

The Department of Energy and the Department of the Army evaluated a wide range of remedial options for groundwater in a joint Feasibility Study in 1998. The Army prepared a Supplemental FS in 2004 to provide further information and analysis of remediation alternatives specific to chemicals of concern at the former WSOW, specifically nitroaromatic compounds. Following the joint Feasibility Study in 1998, an additional 4 years of groundwater monitoring (October 1999 to August 2003) was completed and evaluated in support of a Supplemental FS for the former WSOW. This groundwater monitoring data, located in the GMAR, provided information used to evaluate the feasibility of natural attenuation at the site. In addition, DOE conducted extensive field-testing in 1998, 2001, and 2002 which demonstrated active treatment remedies for groundwater were ineffective due to geological characteristics of this area. As a result, the Supplemental FS presented five remedial alternatives.

2.9.1. Alternative 1: No Action

The No Action alternative is evaluated as a baseline for comparison with the other alternatives. Monitoring data would not be collected under this alternative. Institutional Controls (ICs) would not be provided. The existing network of monitoring wells would be abandoned. The estimated total present net-worth cost is \$140,000.

2.9.2. Alternative 2: Long-term Monitoring

Long-term monitoring (with no active remediation) does not involve groundwater extraction, insitu or ex-situ treatment, or containment actions. Although naturally occurring physical, chemical and biological processes are reducing the contaminant concentrations, this alternative



does not provide a mechanism for monitoring these natural processes (dilution, dispersion, adsorption, biodegradation, and photolytic degradation). This alternative provides data on contaminant concentrations. Further, monitoring of the contaminants of concern would only be conducted at the WSOW boundary to ensure that contaminants are not migrating offsite.

The implementation of ICs is a necessary component of this alternative. ICs would be needed to ensure protection of human health and the environment during the remedial action period to restrict use of groundwater for drinking water purposes and to prevent downward migration of contamination, through the installation of wells, to the primary drinking water aquifer.

For the IC component of this alternative, mechanisms that are appropriate with regard to land ownership and that are considered to be implementable, reliable, and enforceable were considered. The affected land area would involve federally-owned and state-owned properties. Restrictions on groundwater and spring water use would be implemented at the Department of Defense owned properties and the Missouri Department of Conservation properties through proprietary controls. The anticipated IC area encompasses the WSTA, the August A. Busch Wildlife Area to the north and northeast of the WSTA, and the Weldon Spring Conservation Area to the south and southeast of the WSTA. The anticipated IC areas are based on the impacted Spring Basin Recharge Areas (Figure 3). ICs would remain until ARARs or health based remediation goals are met (Table 2.8-1). Variation by contaminant and location is expected, with some areas of higher concentration (such as MWV09) requiring ICs for approximately 160 years. However, because the monitoring program would be limited to the WSOW boundary, the basic monitoring program associated with this alternative would be insufficient to determine if these standards had been met. The present net worth cost for Alternative 2 is \$610,000.

2.9.3. Alternative 3: Monitored Natural Attenuation

This alternative would involve the collection of monitoring data, in accordance with EPA's MNA Guidance, to verify the effectiveness of naturally occurring processes to reduce contaminant concentrations and an evaluation of the naturally occurring reduction in contamination. Monitoring data collected for this alternative would be obtained throughout the WSTA to evaluate the reduction of contaminant concentrations. This data may include an analysis of the each contaminant of concern (COC), in addition to attenuation parameters, throughout a much larger well network than discussed in Alternative 2. Dilution, dispersion, adsorption, biodegradation, and photolytic degradation are the natural processes identified that are reducing contaminant concentrations in groundwater at the WSOW area. Dilution and dispersion are the primary attenuation processes. Biodegradation may also be a significant factor in wells that show favorable conditions for this process, but will not be a significant factor compared to dilution and dispersion.

Because of the wide range in hydraulic conductivities and the karst/fractured nature of the aquifer across the contaminated areas, estimated remedial time frames include a degree of uncertainty. However, on the basis of predictive calculations, it is anticipated that the groundwater contaminant concentrations will attenuate to levels meeting remediation goals within a reasonable time period. ICs, as discussed in Alternative 2, would also be provided with this alternative. ICs would remain until ARARs or health based remediation goals are met



(Table 2.8-1) which is considered to be unrestricted use at this site. Variation by contaminant and location is expected, with some areas of higher concentration (such as MWV09) requiring ICs for approximately 160 years. It is anticipated that most other groundwater areas will meet remediation goals within 30 years. The present net worth cost of this alternative is \$990,000.

2.9.4. Alternative 4: Groundwater Extraction

This alternative includes the design and installation of a groundwater treatment system. The extraction and treatment system is specific for locations on-site with higher concentrations of contamination and does not include other areas of the site. This remedy is addressing the two areas on-site which have demonstrated significant contamination, MWS12 and MWV09 (Table 2.5-1; locations shown on Figure 3 as MW12 and MW09). This alternative also includes placing dams at 3 springs and attempting to contain their flows to provide for a constant treatment rate. All other areas will be addressed through Monitored Natural Attenuation as described in Alternative 3. Groundwater monitoring data would be collected concurrently under this alternative. ICs may also be provided as discussed under Alternative 2. ICs would remain until ARARs or health based remediation goals are met (Table 2.8-1). Variation by contaminant and location is expected, with some areas of higher concentration (such as MWV09) requiring ICs for approximately 160 years. Remediation under this alternative is predicted to take 160 years. It is anticipated that some groundwater areas currently impacted will meet remediation goals within 30 years. The present net worth cost of this alternative is \$8,830,000.

2.9.5. Alternative 5: Enhanced Monitored Natural Attenuation

The natural processes described above in Alternative 3, Monitored Natural Attenuation can be stimulated to occur at a higher rate than would naturally occur via several mechanisms. The aquifer conditions that support biodegradation, (such as low oxygen, reducing conditions), can be affected by injecting nutrients into the aquifer to change the physical conditions to be more conducive to breaking down the contaminants of concern.

This alternative is only appropriate for known areas of contamination; there are only two areas on site that exhibit significant contamination (near MWS12 and MWV09) (Table 2.5-1; locations shown on Figure 3 as MW12 and MW09) where enhancements would be beneficial. Implementation of this technology may also potentially improve conditions observed at downgradient monitoring points. It is also important to note that while TNT and 2,6 DNT are biodegraded under reducing conditions, the highest levels are of 2,4 DNT which degrades aerobically. All other areas will be addressed through Monitored Natural Attenuation as described in Alternative 3. ICs, as discussed in Alternative 2, would be provided. ICs would remain until ARARs or health based remediation goals are met (Table 2.8-1). Variation by contaminant and location is expected, with some areas of higher concentration (such as MWV09) requiring ICs for approximately 160 years. It is anticipated that most other groundwater areas will meet remediation goals within 30 years. The present net worth cost for this alternative is \$2,080,000.



2.10. SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

2.10.1. Overall Protection of Human Health and the Environment

Each alternative, except Alternative 1 will meet the overall objectives of protection of human health and the environment. Since Alternative 1 would not include ICs, groundwater use would not be prevented. Adequate protection of human health and the environment under Alternative 1 would not be provided.

2.10.2. Compliance with ARARs

Each alternative, except Alternative 1 will meet the groundwater ARARs for the site.

2.10.3. Long Term Effectiveness

Alternatives 2 through 5 include groundwater monitoring to evaluate contaminant concentrations to ensure long term effectiveness. Institutional Controls will also provide restrictions to groundwater use above remediation goals.

2.10.4. Reduction of Toxicity, Mobility, Volume Through Treatment

Alternatives 3 through 5 will reduce the mass of contamination on site via natural or enhanced removal processes. Although concentrations will decrease under Alternative 2, the groundwater monitoring will not evaluate degradation products and will not be able to provide data on the occurrence of reduction of contaminants.

2.10.5. Short Term Effectiveness

Each alternative (excluding Alternative 1) includes Institutional Controls to prevent exposure to contaminated groundwater. Regarding potential for accidents to workers, Alternatives 4 and 5 contain an increased likelihood of a work related accident when compared to the other alternatives as Alternatives 4 and 5 require additional construction and clearing/grubbing activities.

2.10.6. Implementability

Alternatives 1 through 3 are readily implementable. Alternatives 4 and 5 would require further investigations or pilot study to determine effectiveness at the site for groundwater extraction or enhancement options. In addition, Alternative 4 and Alternative 5 are not readily implementable due to the site geology which raises issues of locating appropriate extraction well or injection points as well as injecting enhancements.

2.10.7. Cost

Present value calculations were completed using the Feasibility Study Cost Estimating Guidance document (EPA, July 2000; Guide to Developing and Documenting Cost Estimates During the Feasibility Study; EPA 540-R-00-002; OSWER-9355.0-75). The information for the cost estimates is based upon the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements may occur as a result of new information and data collected during engineering design of the remedy. This presents an order-of-magnitude engineering cost estimate that is expected to be within +50% to -30% of the actual project cost.



The present value for each alternative is summarized below:

Alternative 1	\$ 140,000
Alternative 2	\$ 610,000
Alternative 3	\$ 990,000
Alternative 4	\$8,830,000
Alternative 5	\$2,080,000

2.10.8. State Acceptance

"The state supports the selected remedial action of Monitored Natural Attenuation with reliance on institutional controls. Robust long-term stewardship, including institutional controls, are essential for protecting human health and welfare and the environment while allowing continued use of the land.

The state considers Action Specific Applicable or Relevant and Appropriate Requirements (ARAR) as required by the National Contingency Plan (NCP) §§300.430(f)(5) (ii) (B) and (C) an important component of this ROD. The state requests the United States Corps of Engineers include the following Action Specific ARARs for the selected remedial action; 10 CSR Part 23 Well Drillers Law-installation and abandonment of monitoring wells, 10 CSR Part 20-6.010 - proper disposal of monitoring well purge water, and 40 CFR Part 262.11 Resource Conservation and Recovery Act (RCRA)-investigative-derived waste."

2.10.9. Community Acceptance

A majority of the comments received during the public comment period for the Proposed Plan pertained to the CERCLA process. A number of comments were also received that dealt with the amount of detail provided in the Proposed Plan. Commentors were concerned that the DOD had not followed the CERCLA process, had not presented enough support for MNA, and had proposed a remedy that did not maximally protect the public health and the environment. All of these concerns have been responded to in the Responsiveness Summary (Section 3.0) of this ROD.

2.11. SELECTED FINAL REMEDY

2.11.1. Summary of Rationale for Selected Remedy

Alternative 3, Monitored Natural Attenuation is the selected remedy for OU2 Groundwater at WSOW. This alternative provides the best balance of criteria among all the alternatives. Monitored Natural Attenuation is protective of human health and the environment, complies with ARARs, uses permanent solutions and alternate technologies to the maximum extent possible, and is cost effective. This remedial action also satisfies the Remedial Action Objectives (RAO).

Monitored Natural Attenuation was distinguished from the other alternatives due to its cost effectiveness, ability to implement, and demonstrated effectiveness in comparison to Alternative 4 or Alternative 5. The cost comparison between Alternative 2 and the selected remedy is offset by the greater long-term effectiveness due to the differing groundwater monitoring requirements.



2.11.2. Description of the Selected Remedy

The major components of the selected remedy include:

- Collection of monitoring data to verify the effectiveness of naturally occurring processes to reduce contaminant concentrations.
- Use of select wells from the existing groundwater monitoring network to collect groundwater data. Use of select springs at the site for additional monitoring data. The initial monitoring network will be presented during remedial design. This network will be modified over time, if necessary, to aid in evaluation of progress toward the RAO. This modification may include installation of new monitoring wells.
- Institutional controls in areas which exceed remediation goals designed to limit ingestion or dermal exposure to groundwater and prevent use of groundwater contaminated above ARARs or health based remediation goals as a potable water source. The institutional controls would also restrict activities that may negatively impact the remediation of contamination or result in creation of a potential for downward migration of contamination.

The Remedial Design/Remedial Action Work Plan will describe the groundwater monitoring program including performance goals and monitoring strategy and the appropriate response actions should the performance goals not be achieved. The Remedial Design/Remedial Action Work Plan will also describe the ICs, or will reference a separate plan that will describe the ICs.

2.11.3. Performance Monitoring Strategy

Based on the nature and extent of groundwater contamination at the WSOW, the following performance goals are identified:

- 1) Contaminants will attenuate at a rate sufficient to meet cleanup goals in a reasonable time (currently estimated at approximately 160 years);
- 2) Contaminant migration will remain confined to the currently impacted groundwater system; and
- 3) Contaminant levels at potential exposure points (i.e., springs) will not pose unacceptable risks to receptors and will decline over time.

To assure these goals are being met, a groundwater monitoring program will be developed using existing monitoring wells (and any new wells that may be required in the future) to evaluate contaminant behavior over time. Any new well installation or plugging of abandoned wells will follow the Missouri requirements for well construction as identified in 10 CSR 23-4.050 (CSR is Code of State Regulations). The details of the program will be provided in the RD/RA Work Plan but will be initially based on *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites* (OSWER 9200.4-17P) and the Technical Report (USACE EL-99-7, March 1999) *Monitored Natural Attenuation of Explosives in Groundwater - Environmental Security Technology Certification Program Completion Report*.

The initial objectives of the monitoring program are:

1) Verify that contaminant concentrations are declining with time at a rate and in a manner so that cleanup standards will be met in approximately 160 years;



- 2) Ensure that the lateral migration does not significantly extend beyond the current area of impact;
- 3) Monitor the contaminant levels at impacted springs, which are the only current potential points of exposure under current land use conditions; and
- 4) Monitor hydrologic conditions at the site over time in order to identify any changes in groundwater flow direction that might affect the protectiveness of the selected remedy.

The program will likely evolve over time, but will be designed to meet the RAO. The program will be designed to verify that MNA is performing as expected and provide a mechanism for evaluating performance. Moreover, the monitoring program will identify additional monitoring and related activities that may be implemented if it appears that the MNA remedy may not be meeting performance goals. The specific monitoring locations and performance evaluation criteria will be defined in the RD/RA Work Plan that implements this ROD.

2.11.4. Institutional Controls

The implementation of ICs is a component of this alternative. ICs would be needed in impacted areas to ensure protection of human health and the environment until remediation goals are met which is considered to be unrestricted use at this site. To maintain the integrity of the remedial action, ICs are intended to:

- Restrict activities that may negatively impact the remediation of contamination.
- Restrict activities that may result in creation of a potential for downward migration of contamination.
- Reduce the potential for ingestion or dermal exposure to groundwater contaminated at concentrations above remediation goals.
- Prevent use of groundwater contaminated above ARARs or health based remediation goals as a potable water source.

ICs will remain until ARARs or health based remediation goals are met (Table 2.8-1) which is considered to be unrestricted use at this site. Variation by contaminant and location is expected, with some areas of higher concentrations requiring approximately 160 years.

The anticipated IC area encompasses the WSTA, the August A. Busch Wildlife Area to the north and northeast of the WSTA, and the Weldon Spring Conservation Area to the south and southeast of the WSTA. The IC boundary is initially based on the extent of the spring recharge boundaries as shown in Figure 3 and will be refined as part of the Remedial Design.

For the IC component of the selected remedy, instruments or mechanisms that are appropriate with regard to land ownership and that are considered to be implementable, reliable, and enforceable were considered. The affected land area would involve federally-owned and state-owned properties. To restrict groundwater and spring water use effectively, restrictions on groundwater use would be implemented within the WSOW.

The Department of the Army will implement, maintain, and enforce ICs as they apply to currently owned federal property. The implementation, maintenance and enforcement of ICs on state owned property will be addressed during the remedial design. Further definition of ICs on



federal and state property will be provided as part of the remedial design. A remedial design document will be developed to address the MNA remedy and will include details on IC implementation and maintenance actions in accordance with Federal Facility Agreement Section XXIX.B. requirements.

On the state owned property and upon future transfers of Army owned property, compliance with the IC performance objectives may involve actions by the property owners in accordance with deed restrictions or other agreements, however, ultimate responsibility for assuring that the objectives are met remains with Army as the party responsible under CERCLA for the remedy. Army and regulators will consult to determine appropriate enforcement actions should there be a failure of an IC objective at the state owned property or a property transferred in the future.

Proprietary controls, governmental controls, and information devices, as applicable, are being considered. These instruments would specify groundwater and spring water access restrictions for the current owners and users of the land. These instruments would also give continued access to monitor and analyze the groundwater for a period of time to be defined.

2.12. STATUTORY DETERMINATIONS

In accordance with the statutory requirements of Section 121 of CERCLA, as amended, the remedial action shall be protective of human health and the environment, comply with ARARs, be cost effective, utilize permanent solutions and alternative treatment technologies to the maximum extent practicable, prefer treatment as a principal element, and provide for a five year review.

2.12.1. Protection of Human Health and the Environment

The remedy will be protective of human health and the environment as Institutional Controls will restrict use of contaminated groundwater until contaminant levels have decreased to cleanup standards.

2.12.2. Compliance with ARARs

The selected remedy will comply with all chemical specific ARARs as presented in Table 2.8-1.

2.12.3. Cost Effectiveness

The selected remedy is considered cost effective because it provides long term effectiveness and permanence at a reasonable cost as compared to the other alternatives.

2.12.4. *Utilization of Permanent Solutions and Alternate Technology*

Dilution and dispersion processes will decrease contaminant levels over a period of time that would allow unrestricted use and constitute a permanent solution. The selected remedy represents the maximum extent to which a permanent solution and treatment technologies can be utilized in a practicable manner at this site.

2.12.5. Preference for Treatment as a Principal Element

The selected remedy does not include treatment as a principal element because the available treatment options were considered ineffective as a means to address the entire site.



2.12.6. Five Year Reviews

This remedy will ultimately result in hazardous substances, pollutants, or contaminants remaining on the site at levels that allow for unlimited use and unrestricted exposure. However, the remediation process will take more than 5 years to achieve these conditions. A Five Year review will be conducted until remediation goals are achieved.

2.12.7. Significant Changes

The selected remedy is the same as the preferred alternative in the Proposed Plan presented to the public for review and comment.

Table 2.5-1: Monitoring Points with Mean Concentrations Exceeding Remediation Standards for the OU2 Groundwater of WSOW

Area	Well ID	Analytical Parameter	Remediation Goal (µg/L)	Mean* (μg/L)
SP-5304	SP5303	2,4,6-TNT	2.8	21.20
SP-5601/5603/5605	MWS16	2,4,6-TNT	2.8	3.00
51 -5001/5005/5005	SP5605	2,4,6-TNT	2.8	25.28
	MWS17	2,4-DNT	0.11	0.13
SP-5602	SP5602	2,4-DNT	0.11	0.18
	SF 3002	2,6-DNT	1.3	1.56
SP-6301	MWV01	2,4-DNT	0.11	0.21
SP-6301/6303	MWS04	2,4-DNT	0.11	0.19
	MWS21	2,4-DNT	0.11	0.23
		2,4,6-TNT	2.8	24.49
	MWV09	2,4-DNT	0.11	37.37
		2,6-DNT	1.3	4.39
		2,4-DNT	0.11	79.85
		2,6-DNT	1.3	59.92
SP-6303/6304	MWS12	1,3-DNB	1	2.98
		o-NT	37	280.39
		p-NT	37	143.17
	USGS4	2,4-DNT	0.11	0.12
	USUS4	2,6-DNT	1.3	2.65
	SP6303	2,4-DNT	0.11	0.12
SP-6501	MWS15	2,4-DNT	0.11	0.28

^{*}Period of evaluation is Round 22 through Round 35 (October 1999 to August 2003)



Table 2.7-1: Non-Cancer Risks Due to Nitroaromatics

Receptor population: Recreational visitor;

Receptor Age: Adult;

Scenario time frame: Current and Future

Exposure Medium	Chemical	Exposure Point Concentration (µg/L)	Critical Effect	Hazard Quotient ^a	
Spring water	1,3,5-Trinitrobenzene (1,3,5-TNB) ^b	0.41	Methemoglobinemia and spleen-erythroid cell hyperplasia	0.000002	
Spring water	2,4-Dinitrotoluene (2,4-DNT)	0.21	Neurotoxicity	0.00002	
Spring water	2,6-Dinitrotoluene (2,6-DNT)	0.41	Neurotoxicity	0.00006	
Spring water	2,4,6-Trinitrotoluene (2,4,6-TNT)	120	Liver effects	0.04	
	Hazard Index at Most Contaminated Spring - SP5303				

Receptor population: Resident;

Receptor Age: Adult; Scenario time frame: Future

Exposure Medium	Chemical	Exposure Point Concentration (µg/L)	Critical Effect	Hazard Quotient ^c
Groundwater	1,3,5-Trinitrobenzene (1,3,5-TNB) ^b	14	Methemoglobinemia and spleen-erythroid cell hyperplasia	0.1
Groundwater	1,3-Dinitrobenzene	0.4	Increased splenic weight	0.1
Groundwater	2,4-Dinitrotoluene (2,4-DNT)	20	Neurotoxicity	0.3
Groundwater	2,6-Dinitrotoluene (2,6-DNT)	2.9	Neurotoxicity	0.08
Groundwater	2,4,6-Trinitrotoluene (2,4,6-TNT)	30	Liver effects	2
Groundwater	3-Nitrotoluene (3-NT or m-NT)	0.13	Splenic lesions	0.0004
Groundwater	4-Nitrotoluene (4-NT or p-NT)	0.22	Splenic lesions	0.0006
Hazard Index in Groundwater in Most Contaminated Well - MWV09 2				

^a Hazard quotient is based on comparison of dose received by recreational trespasser coming to site 20 times a year for 30 years consuming about 400 ml of spring water per trip and wetting 4,200 cm² of skin for 4 hours to the Reference Dose. When dose is equal or less than Reference Dose (HI equal to or less than 1), adverse non-cancer health effects are considered unlikely.

^b Hazard quotient for 1,3,5-TNB is adjusted from value presented in BLRA (DOE and USACE, 1997a) on the basis of a change of Reference Dose from 0.0005 to 0.03 mg/kg/day.

^c Hazard quotient is based on comparison of dose received by future adult resident living on site for 30 years consuming 2 L of water per day and showering for 0.16 hr/day wetting 20,000 cm² of skin to the Reference Dose.



Table 2.7-2: Cancer Risks Due to Nitroaromatics

Receptor population: Recreational visitor;

Receptor Age: Adult;

Scenario time frame: Current and Future

Exposure Medium	Chemical	Exposure Point Concentration (µg/L)	Weight-of Evidence Classification	Cancer Risk ^a
Spring water	2,4-Dinitrotoluene (2,4-DNT)	0.076	B2: probable human carcinogen	4 x 10 ⁻⁹
Spring water	2,6-Dinitrotoluene (2,6-DNT)	1.8	B2: probable human carcinogen	8 x 10 ⁻⁸
Spring water	2,4,6-Trinitrotoluene (2,4,6-TNT)	110	C: possible human carcinogen	2 x 10 ⁻⁷
Ca	3 x 10 ⁻⁷			

Receptor population: Resident;

Receptor Age: Adult; Scenario time frame: Future

Exposure Medium	Chemical	Exposure Point Concentration (µg/L)	Weight-of Evidence Classification	Cancer Risk ^b
Groundwater	2,4-Dinitrotoluene (2,4-DNT)	8.8	B2: probable human carcinogen	7 x 10 ⁻⁵
Groundwater	2,6-Dinitrotoluene (2,6-DNT)	15	B2: probable human carcinogen	1 x 10 ⁻⁴
Groundwater	2,4,6-Trinitrotoluene (2,4,6-TNT)	0.18	C: possible human carcinogen	6 x 10 ⁻⁸
Cancer Risk	2 x 10 ⁻⁴			

^a Cancer risk is the increase in probability that an individual will contract cancer as a result of exposure to contaminants over the natural background risk. The cancer risk is calculated for a recreational trespasser coming to site 20 times a year for 30 years consuming about 400 ml of spring water per trip and wetting 4,200 cm² of skin for 4 hours.

^b Cancer risk is calculated for a future adult resident living on site for 30 years consuming 2 L of water per day and showering for 0.16 hr/day wetting 20,000 cm² of skin.



TABLE 2.8-1: Remediation Standards for the OU2 Groundwater of WSOW

Contaminant of Concern	Standard (µg/L)	Basis of Standard
2,4-DNT	0.11	Missouri Water Quality Standards, 10 CSR 20-7.031
1,3-DNB	1.0	Missouri Water Quality Standards, 10 CSR 20-7.031
NB	17	Missouri Water Quality Standards, 10 CSR 20-7.031
2,6-DNT	1.3	Risk based concentration eqivalent to 10 ⁻⁵ resident scenerio
2,4,6-TNT	2.8	Risk based concentration eqivalent to 10 ⁻⁶ resident scenerio
o-NT	37	Risk based concentration based upon Hazard Index of 1 residential scenerio
m-NT	37	Risk based concentration based upon Hazard Index of 1 residential scenerio
p-NT	37	Risk based concentration based upon Hazard Index of 1 residential scenerio

^{*}The remedial goal for 2,6-DNT was selected on the basis of site specific factors, including technical limitations in achieving cleanup levels greater than a 10^{-5} risk level.



3.0 RESPONSIVENESS SUMMARY

This Responsiveness Summary provides responses from the U.S. Army to comments received during the public comment period for the Proposed Plan held from June 11 to July 12, 2004. The U.S. Army sponsored a public meeting held at the St Charles Community College on June 24, 2004. Both the Missouri Department of Natural Resources and Environmental Protection Agency Region VII provided verbal statements. No members from the public attended. The transcript from the public meeting and comments received during the public comment period are available in the Administrative Record.

Comments and questions from the public have been paraphrased or quoted in italic text. The letter in parentheses following the comment identifies the commentor according to Table 3.1.

3.1. Summary of Comments and Responses

1. Commentor raised concerns that the accelerated schedule did not allow for public participation. Commenter further questioned the public notification process by the U.S. Army Corps of Engineers. (A)

USACE fully complied with all the standards of CERCLA and the National Contingency Plan (NCP) including public participation requirements. As required by the NCP, a public meeting was held in conjunction with a thirty-day comment period designed to receive public comments concerning the proposed remedy for Operable Unit 2 Groundwater. Notice of the public meeting and comment period in addition to the location of the Proposed Plan and all supporting documentation was placed in the St. Charles Suburban Journal (St. Peters edition), a major local paper of general circulation as required by the NCP. This edition covered the local area within and around the WSOW and included Harvester, St. Charles, Weldon Spring, St. Peters, and Weldon Spring Heights at the date of publication.

2. Commentor stated "the WSOW Proposed Plan appears to lack supporting evaluation" and indicated a concern over compliance with CERCLA. (A)

All CERCLA and NCP requirements were met by the USACE at the WSOW. Supporting documentation for the remedy selection is located in the Administrative Record and includes: Remedial Investigation (RI), Feasibility Study (FS), Supplemental Feasibility Study (SFS), Baseline Risk Assessment (BLRA), Groundwater Monitoring Assessment Report (GMAR), and Proposed Plan (PP).

3. Plume maps of current contamination should be included in the Proposed Plan. Commenter also requested information concerning the vertical extent of groundwater contamination and monitoring points mentioned in the text should be identified. (A)

The figure in the Proposed Plan provides the reader with a general overview of the Site. Individuals who wish more specific information are directed to the Administrative Record for more detailed documents. A detailed groundwater map is provided in the GMAR and the Feasibility Study which includes monitoring points and contaminant specific information for wells and springs monitored at the WSOW. The GMAR also provided detailed analysis of the nature and extent of the contamination which included discussion on vertical extent.



4. Commentor requested clarification between DOE WSS and DOD/USACE WSOW property and groundwater boundaries. Information as to whether physical barriers existed and the degree of overlap between the two aquifers at each site was requested. Clarification was requested for groundwater areas included in the DOE ROD as compared to the DOD/USACE Proposed Plan. (A)

DOE and DOD/USACE are addressing contaminated groundwater based on information provided during the RI/FS process. The only common contaminants of concern are the nitroaromatic compounds. The nitroaromatic contaminated groundwater is being addressed by either DOE or DOD/USACE based on the property on which the source is located.

The impacted groundwater is located in the same aquifer and the nature of the hydrogeology does result in a potential for downgradient "overlap" of the impacted groundwater. DOE and DOD/USACE remedies have been developed to ensure that one does not negatively impact the performance of the other. As contaminant concentrations diminish over time, the extent to which "overlap" is an issue will be reduced as well.

- 5. Commentor indicated Proposed Plan text did not provide specific information and requested additional information on the following: (A)(C)
- (a) state the WSOW EPA Hazard Rating (A)

The WSOW EPA Hazard Rating System (HRS) package was completed in January 1988 identifying an HRS score of 58.6.

(b) ATSDR Health Assessment at WSOW should be mentioned. (A)

ATSDR Health Assessment at WSOW was initiated in February 1991 and completed in June 1995. The DOE and DOD completed a Baseline Risk Assessment in 1997 which under the CERCLA process provides a more quantitative evaluation of the risk at the site. It was used during the evaluation and development of the components for alternatives for groundwater remedial action.

(c) ARARs should be referenced (A)

Both ARARs and health based remediation goals are provided in Table 1 of the Proposed Plan.

(d) Bibliographic entries not numbered in Proposed Plan and need a cross reference to bibliography in RI and FS. (A)

The bibliography portion of the Proposed Plan, RI, and FS provide the reader with adequate information.

(e) Sampling results should be provided from the Missouri Research Triangle (A)

Nature and extent determinations are provided in the RI and GMAR. The irrigation well at the Missouri Research Triangle Park is cross-gradient to the sources of contaminated



groundwater at the site and therefore does not have the potential for impact. Further, EPA investigated the WSOW in 1989 and discovered no disposal areas, contaminated soil, or contaminated surface water in the Missouri Research Park. In 1990, the NPL site narrative was revised to state that the Missouri Research Park is not now considered a part of the NPL site.

(f) Commentor requested an explanation of Karst topography. (A)

A complete description of Karst topography is located in the RI with summaries provided in the GMAR and the Supplemental Feasibility Study. The definition of Karst topography is also located in the glossary of the Proposed Plan.

(g) Commenter noted that the Weldon Spring Heights also has a well in the St Peters Sand Stone that provides the primary drinking water and they are drawing water from 450 ft below the well head. (C)

This well is located cross-gradient from the contamination and therefore does not have the potential for impact. Further, the well is drawing water from the St. Peters Sandstone. The shallow aquifer in the weathered Burlington-Keokuk is the impacted aquifer at the WSOW.

6. "Clearly explain PRG's and define the source and rationale behind "recreational exposure scenario" (A)

The Baseline Risk Assessment provides detail on the scenarios developed (what is the exposure pathway, how often does exposure occur and for how long) to characterize and assess the risk at the WSOW. Under current land uses, the most likely receptor would be a recreational visitor who might be exposed to contaminated discharge water at one of the springs.

The use of this scenario in assessment of risk aids in identifying whether or not existing exposure routes pose a risk to receptors. The principal route of exposure for a human receptor is considered to be the ingestion of spring water. Dermal exposure to spring water was also calculated, although this exposure pathway would be less significant based on the limited area and depth of most of the springs. Because of the small size of the springs and the very low levels of contamination measured in the spring sediments, the potential for dermal contact with, or ingestion of, sediment is considered to be low. Inhalation was not identified as a pathway of concern because of the absence of volatile organic compounds, radon, and airborne particulates.

These exposure pathways form the basis for assessment of risk associated with the recreational exposure scenario. This exposure scenario was developed as it represents the only complete exposure pathway at the site. Data collected at the springs when compared to Preliminary Remediation Goals (PRGs) derived from the recreational exposure scenario verifies that a recreational visitor who might be exposed to contaminated discharge water at one of the springs is protected.

Exposure scenarios support development of PRGs. PRGs are cleanup levels that are proposed prior to the signing of a Record of Decision (ROD). The PRGs are based on levels



either set in environmental laws or determined by risk assessment methods. PRGs are developed of each chemical of concern by risk assessment methods based on preventing adverse non-cancer health effects and/or limiting the increase in cancer risk to one in a million.

For this site, PRGs were set to be protective of the potential future resident that may use the groundwater as a drinking water supply. These PRGs are also protective of the current and future recreational user. Remediation conducted at the site must reduce contaminant levels to levels at or below the PRGs before the remediation is declared completed.

7. Commentor questioned the reference to the DOE risk assessment if the WSOW and WSS are different sites. (A)

DOE and USACE prepared a joint Baseline Risk Assessment for the entire WSOW.

8. Commentor requests additional explanation for the statement that the extent of contamination is not migrating. (A)

Nature and extent of contamination was discussed in detail in the RI and GMAR. Thirty-six rounds of groundwater sampling have been conducted at the WSOW since 1990 (57 wells sampled in 1990). Additional wells have been added over the years to provide a more comprehensive analysis of the groundwater. The GMAR evaluated 14 rounds (October 1999 to August 2003) for trends in contaminant concentrations and provided additional analysis on nature and extent of groundwater contamination subsequent to the OU1 (soil and pipeline) remedial efforts that resulted in a reduction and/or elimination of sources for groundwater contamination. From the data collected, it has been determined that the extent of contamination has been relatively stable over time and has actually reduced in some areas as a result of the OU1 remedial action.

9. Commentor indicates his preferred alternative is Alternative 4: Groundwater Extraction. (A)

USACE does not believe that Alternative 4: Groundwater Extraction is the best selection of remedial actions for this Site. Although Alternative 4 meets the threshold criteria (the first two of nine criteria), the implementability of this alternative was rated as low (by contrast, Alternative 3: was rated as high, meaning it would be relatively easy to implement).

The Supplemental Feasibility Study provided additional detail on the analysis of Alternative 4. Pump tests conducted at the WSOW identified that capture zones of the extraction systems would be limited due to the existing hydrogeologic conditions. Further, sustainable yields in the impacted areas would be very low. Likewise, the aquifer recharge would be low, resulting in dewatering of the aquifer under pumping conditions. Cost was also considered as it is one of the five balancing criteria. The cost of Alternative 4 is high relative to Alternative 3.

Alternative 3 was presented in the Proposed Plan as preferred over Alternative 4 based on the comparative analysis of these criteria in addition to the remaining three balancing criteria, Long-term Effectiveness and Permanence; Reduction of Toxicity, Mobility, and Volume through Treatment; and Short Term Effectiveness.



10. "Cost should not be considered the most important factor" in remedy selection.

(A) "...the cleanup choice for this groundwater appears to serve two purposes—least cost and easiest. Only groundwater cleanup should have been the decisive factor in this process. (B)

All remedy alternatives presented in the Proposed Plan were evaluated against the nine criteria set forth in the National Contingency Plan and CERCLA. These nine criteria: (1) overall protection of human health and the environment (2) compliance with ARARs (3) implementability (4) long term effectiveness and permanence (5) short term effectiveness (6) cost (7) reduction of toxicity, mobility, or volume through treatment (8) state acceptance and (9) community acceptance are used to compare, analyze, and evaluate the various remedies. Criteria 1 and 2 are threshold criteria. For an alternative to receive further consideration, it must meet these two criteria. The next five criteria (3, 4, 5, 6, and 7) are balancing criteria. Any alternative that meets the threshold criteria is then compared against other alternatives using these criteria. The alternative that is provided the best balance of these criteria is Alternative 3, Monitored Natural Attenuation. Thus, Alternative 3: Monitored Natural Attenuation was presented as the preferred alternative in the Proposed Plan. The last two criteria are modifying criteria. These criteria are addressed in the Record of Decision (See section 2.10). Cost is only one of the considerations in the remedial action selection. Alternative 3: Monitored Natural Attenuation provides the best balance among all nine criteria.

11. Commentor requested that Institutional Controls include a physical barrier to access to Burgermeister Spring and other areas outside the WSTA. "ICs (Institutional Controls) should also include signs that state the nature of each COC (contaminant of concern)." (A)

USACE does not believe that signage or physical barrier access is an appropriate or effective method of institutional control for this site.

12. "Alternative 3 preferred by the Army does not provide adequate protection by 'eliminating human exposure to COCs'". (A)

CERCLA does not require elimination of all exposure to chemicals of concern. Current exposure to COCs does not pose a risk based on the recreational exposure scenario. All existing points at the site are within the NCP risk range of 10⁻⁴ to 10⁻⁶ for recreational exposure at the site. There are only a few distinct areas at the site where groundwater exceeds risk for residential exposure. Alternative 3: Monitored Natural Attenuation provides adequate protection at these areas to prevent exposure to groundwater.

13. Commentor indicates nature and estimated effectiveness of ICs (Institutional Controls) are not stated. (A)

USACE believes that Institutional Controls are sufficiently described in the Supplemental Feasibility Study and the Proposed Plan for the purpose intended of remedy selection.

14. "There is no scientific data provided in this Proposed Plan that Alternative 3 will work". (A) USACE presented in the Groundwater Monitoring Assessment Report (GMAR) the results of 14 rounds of groundwater monitoring (October 1999 to August 2003) and chemical data



which provides the scientific basis that natural attenuation is occurring at the site. The three objectives of the GMAR were

- (1) Supplement previous evaluations of the fate and transport as well as a determination of nature and extent of groundwater contamination at the WSOW.
- (2) Determine trends of nitroaromatic and nitrate concentrations in the groundwater following the removal of contaminated soil and pipelines completed as part of Operable Unit 1 (OU1).
- (3) Provide rationale for development of a supplemental Feasibility Study that will add Monitored Natural Attenuation as a potential groundwater remedy to the remedies proposed in the 1998 Feasibility Study.

Each of these objectives were addressed in the GMAR. A summary of the analysis completed in the GMAR was provided in the Supplemental Feasibility Study and Proposed Plan. These documents are available in the Administrative Record.

The GMAR included a formal conclusion that the intrinsic natural mechanisms at the WSOW provide strong support for the feasibility of natural attenuation of groundwater contamination. On the basis of the evaluation of data presented and the review of site history, geology, and hydrogeology included as part of the GMAR, preparation of a Supplemental Feasibility Study including Monitored Natural Attenuation as one of the evaluated remedies was recommended.

Table 3.1-1: Comment Letters Received During the Comment Period

Letter Identifier	Commentor/Affiliation	Address
Α.	Daniel W. McKeel, Jr., M.D.	5587-C Waterman Blvd.
		St. Louis, MO 63112
В.	Mary A. Halliday	3575 Hwy D
	RAB* Member	P.O. Box 3
		Defiance, MO 63341
С.	Thomas C. Nelson	25 North Drive
	RAB Member	Weldon Spring Heights, MO 63304

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4.0 REFERENCES

Missouri Department of Natural Resources Division of Geology and Land Survey, 1991, *Shallow Groundwater Investigations at the Weldon Spring Training Area, St. Charles County, Missouri*, Prepared for the USACE-KCD by the MDNR (Price, P.), October.

- U.S. Army Corps of Engineers and U.S. Department of Energy, 1997a, *Baseline Risk Assessment for the Groundwater Operable Units at the Chemical Plant Area and the Ordnance Works Area, Weldon Spring, Missouri*, DOE/OR/21548-569, prepared by Argonne National Laboratory, Argonne, IL, for U.S. Department of Energy, Weldon Spring Site Remedial Action Project, Weldon Spring, MO, and U.S. Department of the Army, Corps of Engineers, Kansas City District, Kansas City, MO, July.
- U.S. Army Corps of Engineers and U.S. Department of Energy, 1997b, *Remedial Investigation for the Groundwater Operable Units at the Chemical Plant Area and the Ordnance Works Area, Weldon Spring Site, Weldon Spring, Missouri,* DOE/OR/21548-571, Final, prepared by MK-Ferguson Company and Jacobs Engineering Group, Inc., Weldon Spring, MO., and Argonne National Laboratory, Argonne, IL For U.S. Department of Energy, Weldon Spring Site Remedial Action Project, Weldon Spring, MO, and U.S. Department of Army, Corps of Engineers, Kansas City District, Kansas City, MO, July.
- U.S. Army Corps of Engineers and U.S. Department of Energy, 1998, Feasibility Study for Remedial Action for the Groundwater Operable Units at the Chemical Plant Area and the Ordnance Works Area, Weldon Spring, Missouri, DOE/OR/21548-569, Final, prepared by Argonne National Laboratory, Argonne, IL For U.S. Department of Energy, Weldon Spring Site Remedial Action Project, Weldon Spring, MO, and U.S. Department of Army, Corps of Engineers, Kansas City District, Kansas City, MO, December.
- U.S. Army Corps of Engineers, 2004, *Groundwater Monitoring Assessment Report, Former Weldon Spring Ordnance Works, Weldon Spring, Missouri*, Final, prepared by the U.S. Department of Army, Corps of Engineers, Kansas City District, Kansas City, MO, May.
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- U.S. Army Corps of Engineers, 2004, *Proposed Plan for Remedial Action for the Groundwater Operable Unit, Operable Unit 2, Former Weldon Spring Ordnance Works, Weldon Spring, Missouri*, Final, prepared by the U.S. Department of Army, Corps of Engineers, Kansas City District, Kansas City, MO, June.